pictures, a number of which showed resemblance in subject or treatment to other pictures in the series. As was to have been expected from the nature of the experiment, the general effect is more important in both cases than details.

The general results of this study may be summed up as follows: The central processes of recognition in the case of ordinary magazine pictures take place in a fifth of a second or less, on the average, the time decreasing as the familiarity increases. Whether the judgment that a picture is known takes place more quickly than the judgment that it is unknown, seems to depend on the mental attitude of the subject—more quickly if he expects the exhibition of known pictures, less quickly if he expects the reverse. Differences in the facility of recognition are found with different pictures, depending chiefly, it would seem, upon their ability to arouse interest, or, in other words, to compel attention.

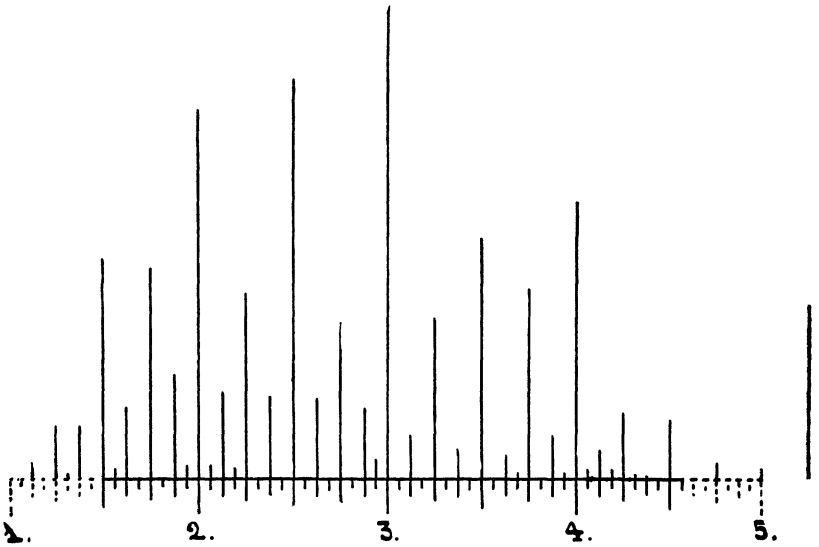
XIV. Notes on Mental Standards of Length.

By F. W. Colegrove.

The ability to make estimates of length presupposes some sort of mental standard which is applied to the length in question. The existence of such standards is very easy to demonstrate, and has even been found a serious obstacle in certain forms of psychophysical experimentation. Some effort has been made to find how accurately these mental standards coincide with the external units that they represent, but so far as the writer is aware no one has tried to investigate the nature of these scales and their mode of application. The present fragment unfortunately does not go far toward filling this gap, but may, at least, call attention to the matter as a subject for investigation. It would be interesting from the point of view of individual psychology if we could know, for a considerable number of persons, the nature and origin of their full equipment of mental standards—for weight, capacity, temperature, angular measure and money value, as well as for length.

The method of the present study was simple in the extreme, and the results can be briefly stated. Fifty circles, differing in diameter by sixteenths of an inch, and forming a continuous series from one and a half inches to four and nine-sixteenths inches, were drawn upon cards of convenient size. A similar set of straight lines of length equal to the diameters of the circles was also prepared, and was submitted with the circles to the subjects for estimation. The subjects were ten in num-

ber, including one who estimated the circles but not the lines. Six were university students (four were of the psychological department), and of the remaining four, one was the wife of a university student, one a carpenter, and one an expert machinist. The combined results of both series and for all subjects are exhibited in the following diagram. The short lines



projecting downward from the horizontal are intended to represent the objective scale, as ordinarily cut on measuring rules. The portions at the left of the one and a half inch mark and to the right of the four and nine-sixteenths inch mark are put in in broken lines to indicate that while not actually found on any of the cards presented, they were trespassed upon by estimates of the subjects. The longer lines erected upon the upper side of the horizontal are intended to indicate the relative frequency of estimates of the extent given by the division of the scale above which they stand. The estimate "three inches," for example, was recorded 110 times; that of "two and fifteen-sixteenths" (next line to the left) 4 times; that of "three and one-eight" (next line to the right) 10 times. The detached line at the extreme right shows the relative frequence of estimates based upon other than the 2, 4, 8, 16, division of the inch; they were chiefly thirds, with occasional fifths and sixths; no other irregular fractions were given by the subjects.

It is easy to see from the diagram that estimates in sixteenths are infrequent. The eighth divisions are maintained throughout from one to four and a half inches. The quarters

are well marked, and the halves and whole inches best of all. The estimate "three inches," approximately the middle extent of the range used, was the most frequently given. In the eighths and quarters there is, as might be expected, a tendency to diminish in frequency from left to right, and this would doubtless have been much more marked had the range been more extended. Such a decrease in the fineness of the estimation scale with increase in its extent is easily verified in introspection, and is probably a case of the same sort of relativity that finds expression in Weber's Law, at least in its application to visual extents.

In a certain sense the diagram above may be said to represent the average mental scale from one and a half to four and a half inches, but it is in no sense to be taken as a picture of such a scale. The mental scale is probably a much more complex affair. It seems likely that most of us carry separate standards for the principal extents; 1, 1½, 2, 2½, 3 inches, and so on, and in estimating, classify first according to these. Then, if pressed for finer judgments, we estimate the excess or defect of the given extent in comparison with the nearest of these standards in such fractions of an inch as we have at command, and so arrive at a final estimate. The grouping of the sixteenths near the whole inches to be observed in the diagram, would accord well with such a process.

The subjects showed considerable individual differences in their fineness of estimate. Of the twenty-two estimates involving sixteenths, seventeen were given by the machinist, four by the lady and one by one of the psychologists.

Several subjects rarely estimated in eighths, and one used no eighths and only five quarters in fifty judgments. These differences are doubtless largely due to differences in practical familiarity with the measuring rule, but also perhaps in part to a difference in the seriousness with which the task was undertaken. The unusual fractions, thirds, fifths and sixths, were used to some extent by five subjects; with one exception, by those whose scale was not otherwise very finely divided. The use of these unusual divisions seems to indicate reliance upon a standard inch divided off-hand as occasion required.

The experiments, as arranged, were not adapted to test the objective truth of the estimates, but there seems to be a general tendency toward under-estimation. It was expected that this would be marked in the case of the circles, following the well-known illusion which affects circles when compared with squares of equal breadth, but the circles do not appear to have been more underestimated than the lines.

With a view of studying the ability of the subjects to estimate extents of less than an inch, the following variation of the

experiment was tried with eight of the previous subjects, the machinest not being included, however. A Brown & Sharpe micrometric gauge was set at the even tenths of an inch from 0.1 to the full inch and the subjects were asked to estimate the separation of the jaws. In this case all the subjects but one used divisions as fine as sixteenths, and one went as far as sixty-fourths. The remaining subject gave no fraction with larger denominator than six. One gave estimates in unusual fractions (thirds and fifths) but no one ventured on a decimal division.

Other tests were made in which the subjects drew their standards for the whole inches from one to five, and still others in which the lines were estimated from memory after a few minutes interval, but not in sufficient number to warrant presentation of the results.